ner. Our San Joaquin Valley station, near Tulare, has suffered almost a total loss of its fruit crop, and even barley has been frosted so badly that it will make no grain, but had to be cut for hay. It is thus evident that the observations of extremes, as well as of means, should be most carefully made and faithfully kept; to insure this our stations should be equipped with self-recording instruments.

TOTAL SNOWFALL FOR THE WINTER 1895-96.

In the REVIEW and SUMMARY for 1895, Vol. XXIII, pp. 491 and 500, the Editor has given the annual snowfall for the so-called snow year, July to June, inclusive, for the ten years 1884-95. The following table gives the corresponding data for 1895-96. In a few cases, where records have been interrupted by discontinuance of stations, the values given by voluntary reporters have been used to complete an annual total. These snowfalls are also reproduced in Chart VII, but lines of equal snowfall are not drawn as the great distance of the stations apart and their diverse locations forbid reliance upon any system of interpolated lines.

Total snowfall at Weather Bureau stations.

(The snowfall is given for the so-called snow year, viz, from July 1, 1895, to June 30, 1896, inclusive.)

Station.	Inches.
Alabama.	
Mobile	T.
Montgomery	T.
Arizona.	
Tucson	0.0
Yuma	0.0
Arkansas.	
Fort Smith	5.0
Little Rock	3.1
California.	
Independence	0.0
Red Bluff	1.0
Sacramento	0.0
San Francisco	0.5
Colorado.	
Colorado Springs	41.2
Denver	58.3
Montrose	36.3?
Pueblo	18.8
Connecticut.	
New Haven	35.1
New London	37.6
District of Columbia.	
Washington	9.3
Florida.	
Jacksonville	0.0
Pensacola	0.0
Tampa	0.0
Georgia.	
Atlanta	0.2
Augusta	T.
Savannah	T.
Idaho.	
Idaho Falls	53.7
Illinois.	
Cairo	13.9
Chicago	56.6
Springfield	16.3
Indiana.	
Indianapolis	46.8
Iowa.	
Davenport	22.8
Des Moines	26.5
Dubuque	33.7
Keokuk	21.2
Sioux City	15.1
Kansas.	
Concordia	15.7
Dodge City	5.3
Topeka	11.4
Wichita	10.7
Kentucky.	
Lexington	28.1
Louisville	32.0
Louisiana.	
New Orleans	0,0
Shreveport	T.
Maine.	
Eastport	57.5
Portland	77.1
Maryland.	
Baltimore	17.0
Massachusetts.	
Boston	38.2
Nantucket	32.0
Vineyard Haven	27.8
Woods Hole	33.9
Michigan.	
Alpena	53.7
Cheboygan	99.8
Detroit	54.3
Grand Haven	58.8
Marquette	105.8
Port Huron	29.2
Sault Ste. Marie	110.7
Minnesota.	
Duluth	40.4
Minneapolis	27.0
Moorhead	43.0
St. Paul	41.5
St. Vincent	52.0?
Mississippi.	
Meridian	T.
Vicksburg	0.0
Missouri.	
Columbia	27.7
Hannibal	21.4
Kansas City	29.3
St. Louis	17.2
Springfield	25.7
Montana.	
Havre	38.5
Helena	58.2
Miles City	23.3
Nebraska.	
North Platte	20.8
Omaha	20.8
Valentine	36.9
Nevada.	
Carson City	27.3
Winnemucca	41.1
New Jersey.	
New Brunswick	5.8
New Mexico.	
Santa Fe	45.4
New York.	
Albany	51.6
Buffalo	72.0
New York	42.0
Oswego	74.9
Rochester	93.8
North Carolina.	
Charlotte	1.1
Hatteras	T.
Kittyhawk	5.0
Raleigh	1.2
Wilmington	12.1
North Dakota.	
Bismarck	37.0
Williston	94.7
Ohio.	
Cincinnati	29.3
Cleveland	48.2
Columbus	27.4
Sandusky	25.2
Toledo	63.7
Oklahoma.	
Oklahoma	5.7
Oregon.	
Astoria	6.0
Baker City	33.2
Portland	9.1
Roseburg	16.7
Pennsylvania.	
Erie	71.8
Harrisburg	32.7
Philadelphia	14.8
Pittsburg	23.3
Rhode Island.	
Block Island	36.4
Narragansett Pier	29.5
South Carolina.	
Charleston	T.
Columbia	0.6
South Dakota.	
Huron	20.1
Pierre	27.3
Rapid City	40.3
Tennessee.	
Chattanooga	1.9

Total snowfall—Continued.

Station.	Inches.
Tennessee—Continued.	
Knoxville	3.5
Memphis	8.6
Nashville	5.0
Texas.	
Abilene	4.0
Amarillo	12.8
Corpus Christi	0.0
El Paso	0.4
Galveston	0.0
Palestine	T.
San Antonio	0.0
Utah.	
Salt Lake City	40.2
Vermont.	
Northfield	89.8
Virginia.	
Cape Henry	3.6
Lynchburg	11.5
Norfolk	5.7
Washington	
East Clallam	37.0
Fort Canby	5.3
Neah Bay	20.0
Olympia	3.0
Port Angeles	18.0
Port Crescent	24.8
Pysht	25.0
Seattle	10.4
Spokane	46.6
Tatoosh Island	7.9
Walla Walla	17.0
West Virginia.	
Parkersburg	32.9
Wisconsin.	
Green Bay	32.5
La Crosse	36.4
Milwaukee	51.4
Wyoming.	
Cheyenne	50.3
Lander	64.6

RÖNTGEN RAYS AND CLOUDY CONDENSATION.

Although meteorologists have not yet ascertained the exact process by which rain drops are made by Nature in her atmospheric laboratory, yet much light has been thrown upon the formation of the little globules of water that make up the ordinary mist and cloud. Among those who have worked upon the subject of the cloudy condensation of atmospheric moisture the most prominent names are: Coulier, of France, John Aitken, of Scotland, Robert, the son of Hermann von Helmholtz, and also Kiessling, both of Germany, and Carl Barus, formerly of the Weather Bureau, Washington. These physicists have shown that when moist air is cooled nearly to the dew-point the aqueous vapor begins to condense by preference upon the minute solid particles which we call dust floating in the atmosphere, no matter what the chemical nature of these particles may be; over the ocean the nuclei are mostly minute crystals of salt; in tropical lands and hot countries they are the spores and cells of debris of cells of vegetable origin; in the smoky atmosphere of large cities, the minute particles of carbon that go to form soot constitute the nuclei. It has not yet been clearly ascertained how the moist air would give up its moisture if there were absolutely no nuclei on which to initiate the condensation. Some consideration of this subject has been indulged in by Von Bezold and slightly modified by the present writer (see "The Production of Rain," in Frear's Monthly Journal Agricultural Science, 1892, Vol. VI, pp. 297-309) to the effect that in the ascending portions of every cloud there are regions that are supersaturated with moisture and that a strained molecular condition is thus produced that eventually and suddenly gives way accompanied by the production of the large drops of rain and electric phenomena. These views on the formation of cloud in the absence of dust were (probably quite independently) investigated by Mr. C. T. R. Wilson, according to an abstract published in Nature, Vol. LII, p. 144, of the paper read by him on May 13, 1895, before the Philosophical Society of Cambridge, England. Wilson found (as, indeed, Espy had done before him, see Espy's Philosophy of Storms, p. 35-36) that—

> If ordinary air is started with, it is found that after a comparatively small number of expansions (due to the removal of the dust particles by the condensation that takes place on them) there is no further condensation unless the expansion exceeds a certain definite amount. With expansion greater than this critical value condensation again invariably takes place, and the critical value shows no tendency to rise, no matter however many expansions be made. The latest result for the ratio of the final to the initial volume, when the critical expansion is just reached is 1.258 (when initial temperature is 16.7° C. = 62.06° F.). This corresponds to a fall of temperature of 26° C. (46.8° F.) and a vapor pressure 4.5 times the saturation pressure for a plane surface of water. The radius of a water drop just in equilibrium with this degree of supersaturation is 0.0000065 cm. = 0.00000256 inch,

assuming the ordinary value of the surface tension to hold for drops of that size.

Quite recently Mr. Wilson, who holds the position of "Clerk-Maxwell student" at the University, Cambridge, England, has added another interesting chapter to our knowledge of this subject.

It will be remembered that in 1868 Tyndall observed that a dense cloud was formed when a powerful beam of light, either electric or solar, penetrated a tube full of dustless, pure vapor. The cloudy condensation thus formed was demonstrably due to the action of the radiation at the blue end of the spectrum and even of the rays beyond that. When freshly formed the cloud was of a brilliant blue, which, however, became white as the particles increased in size. (See Tyndall, Contributions to Molecular Physics, London, 1872.) It is difficult to believe that Tyndall's beam of light carried molecules into the tube, where they acted as dust nuclei to condense the moisture. But now Mr. Wilson has discovered a similar effect when the Röntgen rays are allowed to enter the tube. His account of these newest experiments is published in the Proceedings of the Royal Society of London for March, 1896, Vol. XLI, page 338, from which we make the following extract. Similar experiments had been contemplated in connection with the studies prosecuted at the Weather Bureau at Washington, but, in the absence of the necessary apparatus, their execution has been delayed.

In a paper on The Formation of Cloud in the Absence of Dust, read before the Cambridge Philosophical Society, May 13, 1895, I showed that cloudy condensation takes place in the absence of dust when saturated air suffers sudden expansion exceeding a certain critical amount.

I find that air exposed to the action of Röntgen's rays requires to be expanded just as much as ordinary air in order that condensation may take place, but these rays have the effect of greatly increasing the number of drops formed when the expansion is beyond that necessary to produce condensation.

Under ordinary conditions, when the expansion exceeds the critical value, a shower of fine rain falls, and this settles within a very few seconds. If, however, the same expansion be made while the air is exposed to the action of the rays, or immediately after, the drops are sufficiently numerous to form a fog, which persists for some minutes.

In order that direct electrical action might be excluded, experiments were made with the vessel containing the air, wrapped in tinfoil, connected to earth. This was exposed to the rays; the air was then expanded, the current switched off from the induction coil, and, finally, the tinfoil removed to examine the cloud formed.

As before, a persistent fog was produced with an expansion which, without the rays, would only have formed a comparatively small number of drops.

It seems legitimate to conclude that when the Röntgen rays pass through moist air they produce a supply of nuclei of the same kind as those which are always present in small numbers, or, at any rate, of exactly equal efficiency in promoting condensation.

THE TORNADO OF MAY 25, 1896, IN COOK COUNTY, ILL.

The Editor regrets that an excellent report by Henry J. Cox, Forecast Official, and Charles E. Linney, Observer, Weather Bureau (dated Chicago, August 7, 1896), on the tornado that passed over the northern edge of Chicago on May 25 was received too late for publication in the current REVIEW. In fact, the numerous illustrations make the report too voluminous for the REVIEW and more appropriate for a special publication. According to the authors:

The general atmospheric disturbance, which was attended by tornadoes in northeast Iowa and extreme northern Illinois on the night of the 24-25th of May, 1896, did not appear very threatening on the morning of the 24th. Its center at the 8 a. m. (seventy-fifth meridian time) observation was in Alberta, with a trough of low pressure extending southward to Texas. At the p. m. observation the center had moved slightly eastward, the trough still extending far to the south, with a tendency to form a secondary over western Kansas and another over western South Dakota.

During the daytime of the 24th the barometer fell with moderate rapidity east of the trough, while a high area seemed to be moving into western Montana from the north Pacific Coast. Local conditions, as regards temperature, pressure, and moisture, seemed favorable for the formation of thunderstorms in the southeast quadrant of the low, although there was no apparent indication of unusually severe local storms. Our most severe local storms have frequently occurred when the weather map of a few hours previous showed but ordinary barometric gradient; under such circumstances the local conditions are likely to be sluggish as the storm center begins to move eastward.

This storm developed considerably in intensity during the night of the 24th, the center at the morning observation of the 25th being near Winnipeg, Manitoba. The chart of barometer change of the morning of the 25th shows rapidly falling barometer in front of the trough. This is the usual characteristic of such storms, the central depression increasing decidedly before the upper Lake Region is reached.

During the night of the 24-25th tornadoes occurred in northeastern Iowa and extreme northern Illinois, to be followed during the afternoon of the 25th by a tornado in the southeastern part of Lower Michigan. The main storm continued to increase rapidly during the 25th, its center being at White River, at 7 p. m., where the barometer had decreased to 29.14 inches.

Until the evening observation of the 24th but little rain had fallen in connection with this storm, the precipitation being in the shape of light showers throughout the Northwestern States, except a moderately heavy thunderstorm at Williston, N. Dak. Thunderstorms were general during the night of the 24th in the eastern Dakotas, Minnesota, Wisconsin, northeastern Iowa, northern Illinois, Indiana, and Lower Michigan, the local storms assuming tornadic proportions in the parts of Iowa and Illinois previously referred to. The path of greatest destruction of these severe local storms is shown in Chart G (not printed), but it is not assumed that this path was followed by any single tornado, nor that destructive storms occurred throughout the entire area indicated. There were probably three distinct tornadoes in Illinois in addition to those which occurred in Iowa between 10 and 11 p. m. of the 24th. The tornadoes in Illinois occurred at Egan City and Sugar River, at Elgin, and in Cook County, at about 1 a. m., 1.15 a. m., and 2 a. m., respectively, on the 25th.

The special tornado of Cook County moved at first easterly for about 1½ miles, then southeast for three-quarters of a mile, then north of east and east for over 3 miles, when the path of destruction disappears. "A clear-cut path about one-quarter of a mile wide was visible for about 4½ miles from the Des Plaines River to the north branch of the Chicago River." The tornado occurred about 2 a. m., with heavy lightning and thunder and rain. Most of the trees and debris fell toward the east or northeast. The twisting of houses and tree tops may, as it seems to the Editor, have sometimes been the result of a simple straight-line wind pushing obstacles forward in the direction of least resistance, rather than the result of a whirling wind. In other cases the locations of the debris indicate opposing northerly and southerly winds, and in these regions, therefore, a twisting tornado may be reasonably inferred.

The report is very full of the minor details of destruction, and the meteorological maps, charts, and diagrams are very satisfactory. In general, and in view of the great number of storms that invite investigation, one is forced to consider what items are worthy of observation and description in order to advance our knowledge of the origin of such storms, the laws that control them, and the method of avoiding them.